DOCUMENT RESUME

ED 239 843 SE 041 777

TITLE STS-9 and Amateur Radio. NASA Educational Briefs for the Classroom.
INSTITUTION National Aeronautics and Space Administration, Washington, D.C.
REPORT NO EB-83-9
PUB DATE 83
NOTE 5p.
PUB TYPE Guides - Classroom Use - Materials (For Learner) (051) -- Guides - Classroom Use - Guides (For Teachers) (052)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Aerospace Technology; *Broadcast Reception Equipment; Electronic Equipment; Postsecondary Education; Radio; Secondary Education; *Telecommunications
IDENTIFIERS Ham Radio; PF Project; Radio Operators; *Space Shuttle; *Space Transportation System

ABSTRACT

Designed for secondary and postsecondary school students, the article discusses the STS-9 (Space Transportation System), a hand-held amateur radio (ham) station used on the Space Shuttle Columbia. The article details the mechanics of this battery-powered unit and how it is used. Separate sections discuss necessary equipment for picking up space shuttle signals, post cards used by "ham operators" to confirm two-way contact or reception of signal (QSL Cards), the definition of a "ham operator," license requirements for radio amateurs, call signs, organizations to contact, and questions and activities for use in the classroom. (LH)

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NASA Educational Briefs for the Classroom.

STS-9 and Amateur Radio.

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NASA Educational Briefs

An Educational Publication of the National Aeronautics and Space Administration

For the classroom

STS-9 and Amateur Radio

"W5LFL, from the flight deck of the Space Shuttle *Columbia*." For the first time ever, citizens from localities all over the world will have a chance to talk directly with an astronaut in orbit when the STS-9 (Space Transportation System) lifts off from the Kennedy Space Center carrying the first Amateur (ham) Radio station into orbit.

Dr. Owen Garriott, a NASA mission specialist astronaut and Amateur Radio operator, call sign W5LFL, will use a hand-held radio during part of his off-duty time to communicate with as many of the "ham" operators around the world as his leisure schedule will permit.

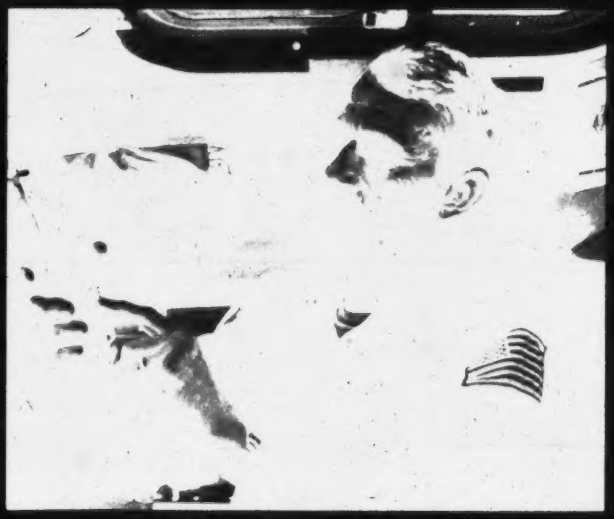
Dr. Garriott has been interested in carrying a ham radio into space since his Skylab mission in the early 1970s. Because the plan to do so came too late in the development of the program, it was rejected.

Space Shuttle flights presented another opportunity. The American Radio Relay League (ARRL) and the Amateur Radio Satellite Corporation (AMSAT) jointly requested that NASA supply two small transceivers (one spare) to be carried by Garriott on STS-9. NASA accepted the proposal with the stipulation that the activity would not interfere with mission activities and that safety requirements would be met.

STS-9 is also launching Spacelab, the European Space Agency's (ESA) manned laboratory. Two constraints to operating the transceiver are that it does not affect Spacelab's mission or payload objectives and will not cause communications interference with the Shuttle orbiter or Spacelab.

The radio will be operated from the aft flight deck of the Space Shuttle orbiter *Columbia*, which will carry the Spacelab in its cargo bay.

Dr. Garriott's FM transceiver will be a battery-powered unit capable of five watts of output power. The antenna (split-ring on a printed-circuit board) will be placed in the upper crew compartment window on the aft flight deck. Garriott will wear the standard in-flight headset when operating the radio. Crew members aboard the Spacelab 1 flight will work on a 12-hour-on, 12-hour-off schedule. Use of the transceiver which weighs 1.5 pounds and has a volume of about 30 cubic inches, will be limited to one hour a day during Dr. Garriott's off-shift time, when no other flight activities (or sleep periods) are scheduled.



Owen Garriott in aft flight deck

Orbit numbers and ground tracks for potential Amateur Radio operations are being prepared and will be identified prior to flight. During the course of the mission Dr. Garriott will operate the amateur transceiver on a portion of 10–15 orbits at most. Starting on day 3 of the nine-day mission, Dr. Garriott will provide one or two hours advance notice of his intention to operate the Amateur Radio transceiver. He will announce this to Mission Control on the orbiter's normal air-to-ground frequency. The announcements will then be disseminated through AMSAT nets, W1AW bulletins, and a special "900" telephone number that will be announced prior to launch.

All ham radio operation for STS-9 will be in the Amateur Radio 2-meter band (144–148 MHz). Dr. Garriott's transceiver will have the capacity to transmit and receive on channels 20-kHz apart. The planned operating frequency range is: Space-to-Earth, 144.510–145.770 MHz; Earth-to-Space, 144.910–145.470 MHz. To simplify procedure, Dr. Garriott will transmit on one or two frequencies only to make it easier to locate him. He will receive on 10 to 20 different frequencies so hams can spread out across the band and not pile up on one frequency. The primary frequency Dr. Garriott will be using when transmitting over the United States is 145.55

MHz. Although only licensed Amateur Radio operators will be allowed to transmit signals, anyone with an interest can listen in. All that will be needed to listen is a receiver (such as a scanner) capable of tuning to 145.55 MHz.

As *Columbia* approaches the portion of the ground track where Amateur Radio operations are planned, Dr. Garriott will call and listen on alternate minutes. He will transmit continuously for one minute, beginning on the even minutes, and will receive continuously for one minute, beginning on the odd minutes. Be sure to synchronize your station clock to WWV, plus or minus two seconds. WWV is an international time signal based on a time standard at Fort Collins, Colorado, broadcast on 2.5 MHz, 5 MHz, 10 MHz, 15 MHz, etc.

During a typical even-minute transmission period, Dr. Garriott will identify a geographical area that he will be listening for and announce the frequency range he will be using. He will also, as time permits, describe crew activity or views of Earth.

During the odd-minute receive period, Dr. Garriott will scan the announced receive frequencies for call signs from the designated area only. To establish contact, an Amateur Radio operator will send his/her *call sign only*, repeating it several times during the scanning period.

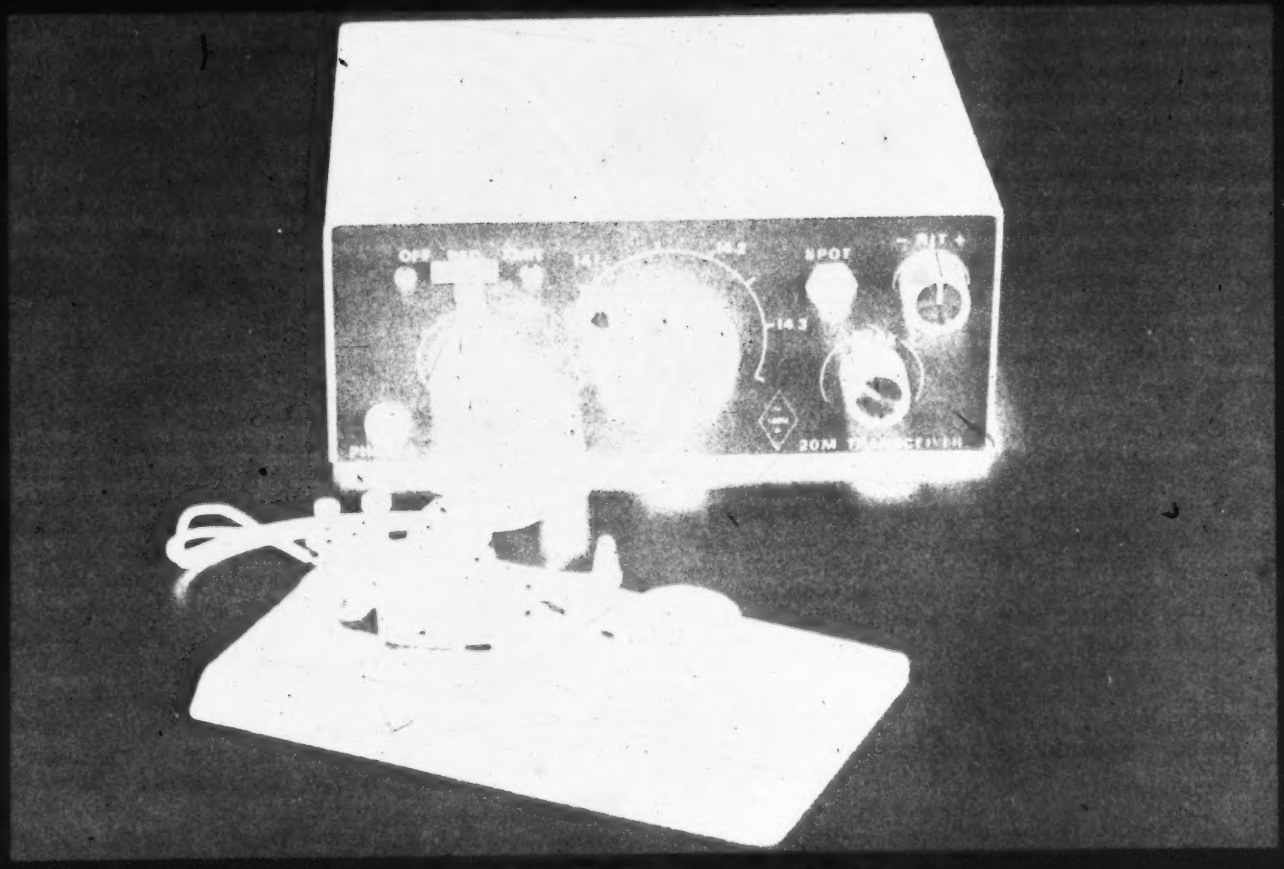
During the next transmission period, on the even minute, Dr. Garriott will acknowledge all call signs he has heard during the listening period. No other report will be needed; call-sign identification constitutes a two-way contact. This procedure will give more operators a chance to make a contact. If time permits, some stations may be called on for short transmissions to fill the time period.

The orbital parameters, 57 degree inclination, 90 minute, 155 nautical miles altitude orbit, will enable most of the Earth's land mass to be within line-of-sight transmission of the spacecraft on a typical day. However, the maximum time of acquisition from any given geographic point to the loss of signal at that same point will be only eight minutes. Access time will be shorter if the spacecraft passes closer to the horizon at your location; therefore accurate timing is essential.

Equipment

An elaborate station setup is not required for making a 2-meter contact. AMSAT recommends no more than 10 watts of output FM signal into a turnstile antenna mounted above any obstructions to have the best chance of being heard by W5LFL. Dr. Garriott, AMSAT, and the ARRL all request that high power amplifiers be avoided. High power will add little to your chance of making contact.

Dr. Garriott has stated that a single monopole (vertical) antenna would be very desirable because it has a fairly good radiation pattern at low elevations



Minimum equipment required to communicate with STS-9

and the Shuttle would seldom pass directly overhead. Due to the short pass time, (STS-9 will be traveling with a forward orbital velocity of 17,000 mph), highly directional equipment could be a hindrance.

Special split-frequency capability will not be necessary because the planned operation calls for separate listen and transmit periods. With the exact frequencies of operation, one can monitor the Space-to-Earth frequencies during the even minutes and switch to the Earth-to-Space frequency of your choice for transmission.

It will be possible to track *Columbia* with a computer tracking program. If you have a computer or programmable calculator and need a program, write to AMSAT Software Exchange, Box 27, Washington, DC 20044. The orbital parameters will be broadcast on W1AW bulletins and AMSAT nets.

QSL Cards

Specially designed QSL cards (post cards used by hams to confirm two-way contact or reception of signal) will be available to anyone who sends a reception report of the Amateur Radio operation from Space Shuttle *Columbia*. Nonamateurs can listen in on a ham's receiver or monitor on scanners to qualify for the special QSL. Send all reception and confirmed contact reports to ARRL, STS-9, 225 Main Street, Newington, CT 06111.

The real key to making a contact will be being in the right place at the right time and following proper procedure, because there will probably only be a single opportunity when the orbiter passes within your range.

The FCC has granted permission to all NASA centers to rebroadcast radio communications from STS-9. These rebroadcasts can be heard on any 2-meter amateur radio or on a police radio or scanner.

What is a "Ham" Operator?

More than one and a half million persons worldwide and over 400,000 Americans are currently licensed Amateur Radio operators or "hams."

Oddly enough, there is no universally accepted explanation of where the popular term "ham" originated. Various theories have been propounded and all generally discredited. The most likely explanation is that the term derives from the frontier day custom of referring to an unskilled or inept telegraph operator as ham-fisted. Regardless, it is a term in which amateurs take great pride.

The term *amateur* refers to one who engages in a pursuit as a pastime rather than as a profession. Amateur Radio is the personal use of short wave radio equipment for direct, world-wide communications on a one-to-one basis. Amateur Radio has been a source of communicating and technical skills, especially during emergencies, but hams never accept compensation for services they provide.

Licenses

Every radio amateur must be licensed by the Federal Communications Commission. In order to obtain a license a ham must pass examinations in radio theory and technique and International Morse Code proficiency.

There are radio amateurs from ages 8 to 80 and they qualify for one of five grades of licenses, each at progressively higher levels of proficiency. The licenses are Novice, Technician, General, Advanced, and Amateur Extra. Higher classes of licenses have added operating privileges. The minimum license required to operate on the frequencies to STS-9 is Technician.

Call Sign

The amateur's call letters are issued by the FCC at the time of obtaining a license. The first letter indicates nationality—in the United States, A, K, N and W.

There are several means of communicating with Amateur Radio in addition to Morse Code (radiotelegraphy) and voice transmission (radiotelephony). These include radioteletype, computer-data exchange, and amateur television.

Organizations

AMSAT Radio Amateur Satellite Corporation; founded in 1969, to provide satellites that can be used for amateur radio communication and experimentation throughout the world, and to disseminate information derived from such communications and experimentation. AMSAT's address is P.O. Box 27, Washington, DC 20044.

ARRL American Radio Relay League; founded in 1914, as the hams' own organization; publishes a monthly technical journal, annual handbook, and is the representative body with the FCC. Send inquiries to 225 Main Street, Newington, CT 06111.

The Amateur Radio Newsletter, *The Westlink Report*, formerly *Ham Radio Report*, Poco Press, 11119 Allegheny Street, Sun Valley, CA 91352.

Questions and Activities for the Classroom

1. All Radio Amateurs must pass a proficiency exam in International Morse Code. Have your students research the history of this means of communication.
2. Contact a local ham operator and arrange for a demonstration of amateur radio techniques. Determine when the shuttle will be making a pass over the area and listen for Owen Garriott's transmission.
3. What is an amateur radio station and what equipment is essential?
4. What are the differences in amateur radio and citizens band radio?
5. Describe methods in which Radio Amateurs can provide a service in the public interest.